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states that:

- (1) I am fully conversant both with the Japanese and English languages.
- (2) (A) I have translated into English, Japanese Patent Application Number 2000-114912/2000-127191, filed 17.04.2000/27.04.2000. A copy of said English translation is attached hereto.
- (2) (B) I have carefully compared the attached English-language translation of Japanese Patent Application Number \_\_\_\_\_ filed \_\_\_\_\_ with the original Japanese-language patent application.
- (3) The translation is, to the best of my knowledge and belief, an accurate translation from the original into the English language.

Date: July 1, 2004

  
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(Type name of translator above)



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**【Name of Document】 Specification**

**【Title of Invention】 EARPHONE SET**

**【Scope of Claims for Patent】**

5      **【Claim 1】 An earphone set comprising a connection plug for being connected to an earphone and / or a microphone and an output terminal, and a signal cable for connecting these, wherein a high-frequency current suppressor consisting of soft magnetic material is added at least partially to the elements thereof.**

10     **【Claim 2】 An earphone set as claimed in claim 1, wherein a part or a whole of outer circumference of said signal cable is covered by said high-frequency current suppressor.**

15     **【Claim 3】 An earphone set as claimed in claim 1 or 2, wherein a part or a whole of outer circumference of an inner conductor of said signal cable is covered by said high-frequency current suppressor.**

20     **【Claim 4】 An earphone set as claimed in any one of claims 1 through 3, wherein said high-frequency current suppressor is provided near a portion where said signal cable and said earphone are connected to each other.**

25     **【Claim 5】 An earphone set as claimed in any one of claims 1 through 4, wherein said high-frequency current suppressor is included inside said earphone as an element.**

**【Claim 6】 An earphone set as claimed in any one of claims 1 through 5, wherein said high-frequency current suppressor is included inside said microphone as an element.**

30     **【Claim 7】 An earphone set as claimed in any one of claims 1 through 6, wherein a case of said earphone or said microphone is a molded material consisting of said high-frequency current suppressor.**

**【Claim 8】 An earphone set as claimed in any one of claims 1**

through 7, wherein said high-frequency current suppressor is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al, and binding material.

5       **【Claim 9】**     An earphone set as claimed in any one of claims 1 through 7, wherein said high-frequency current suppressor is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

10      **【Claim 10】**    An earphone set as claimed in any one of claims 1 through 7, wherein said high-frequency current suppressor is consisting of a thin film of magnetic loss material granular magnetic thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting 15 of insulating material including at least more than one kinds of elements other than said Fe, Co, Ni.

**【 Detailed Description of the Invention】**

**【 0001】**

**【 Technical Field of the Invention】**

20       The present invention relates to an earphone set used for various electronic information equipment, such as a terminal equipment for mobile communication, or the like, and especially to an earphone set which is added to high-frequency current suppressor for preventing the electromagnetic wave to a human body from a 25 terminal equipment or the like.

**【 0002】**

**【 Prior Art】**

Conventionally, in various terminal equipment for mobile communication, an earphone set has been utilized to enable a user to

enjoy music or movies. This makes hands-free communication available, namely makes it unnecessary for a user to hold the terminal equipment for mobile communication directly in his hand.

#### 【 0003 】

5 A cable length of the signal cable ranges from several tens centimeters to a hundred and several tens centimeters. In addition, the cable length corresponds to order of wavelength in microwave band used for mobile communication.

#### 【 0004 】

##### 10 【 The problem that the invention intends to solve】

However, an output from antenna attached to a terminal equipment for mobile communication is easily conducted to the signal cable of the earphone set due to electromagnetic coupling. As a result, electromagnetic wave is conducted to a head of the user 15 through the signal cable. This sometimes increases localized SAR value.

Thus, electromagnetic waves produced from a terminal equipment for mobile communication or the like cause a problem in which an influence of the electromagnetic waves to a human body 20 becomes serious.

#### 【 0005 】

Various researches have been made in recent years as regards such an influence of the electromagnetic waves to a human body. It is sure that the influence would become serious problem 25 more and more from now on in accordance with further popularization of the mobile communication equipment.

#### 【 0006 】

It is therefore an object of the present invention to provide an earphone set which a high-frequency current suppressor which is

capable of being readily attached to the body of an earphone, a microphone, a part of a signal cable, or the like, and which can reduce unnecessary high-frequency current generated in the signal cable due to induction of the electromagnetic wave produced from a terminal equipment, and the like.

【 0007】

【 Means for solving the problem】

According to the present invention, there is provided an earphone set comprising a connection plug for being connected to an earphone and / or a microphone and an output terminal, and a signal cable for connecting these, wherein a high-frequency current suppressor consisting of soft magnetic material is added at least partially to the elements thereof.

【 0008】

And, according to the present invention, there is provided an earphone set in which a part or a whole of outer circumference of the signal cable may be covered by the high-frequency current suppressor.

【 0009】

Moreover, there is provided an earphone set in which a part or a whole of outer circumference of an outer conductor of the signal cable may be covered by the high-frequency current suppressor.

【 0010】

Further, there is provided an earphone set in which the high-frequency current suppressor may be provided near a portion where the signal cable and the earphone are connected to each other.

【 0011】

And then, there is provided an earphone set in which the high-frequency current suppressor may be included inside the

earphone.

**【 0012 】**

And also, there is provided an earphone set in which the high-frequency current suppressor may be included inside the  
5 microphone.

**【 0013 】**

According to the present invention, there is provided an earphone set in which a housing of the earphone or the microphone may be formed by the high-frequency current suppressor.

**10 【 0014 】**

Furthermore, there is provided an earphone set in which the high-frequency current suppressor may be consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al, and binding  
15 material.

**【 0015 】**

There is provided an earphone set in which the high-frequency current suppressor may be consisting of composite magnetic material which comprises soft magnetic powder obtained by  
20 flattening alloy powder including at least Ni, Fe, and binding material.

**【 0016 】**

There is provided an earphone set in which the high-frequency current suppressor may be consisting of magnetic loss thin  
25 film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material including at least more than one kinds of elements other than Fe, Co, Ni

**【 0017 】**

### 【 Embodiment for carrying out the Invention】

Referring to drawings, description is made about an embodiment of the present invention.

#### 【 0018】

##### 5 (First Embodiment)

Fig. 1 is an explanation view for showing an earphone set according to a first embodiment of the present invention, Fig. 1 (a) is a schematic perspective view showing the earphone set, Fig. 1 (b) is an enlarged view showing a high-frequency current suppressor thereof;

#### 【 0019】

As illustrated in Fig. 1, an earphone set 1 comprises an earphone 11, a microphone 12, a connection plug 13, and a signal cable 14 for connecting the earphone 11 and the microphone 12, and the connection plug 13. Further, the earphone set 1 comprises a high-frequency current suppressor 15 attached to the signal cable 14 at a position near the earphone 11 with covering an external circumferential surface of the cable housing 16 at the position.

#### 【 0020】

20 The high-frequency current suppressor 15 is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material. The high-frequency current suppressor 15 attached to the signal cable 214 with covering an external circumferential surface 25 of the cable housing 16 at the position is formed to have a hollow cylindrical shape having a size of 1.55 mm in inner diameter, 2.20 mm in outer diameter, and 10.0 mm in length.

#### 【 0021】

##### (Second Embodiment)

Fig. 2 is an explanation view for showing an earphone set according to a second embodiment of the present invention, Fig. 2 (a) is a schematic perspective view showing the earphone set, Fig. 2 (b) is an enlarged view showing a high-frequency current suppressor thereof.

【 0022 】

As illustrated in Fig. 2, an earphone set 2 comprises an earphone 21, a microphone 22, a connection plug 23, and a signal cable 24 for connecting the earphone 21 and the microphone 22, and the connection plug 23. Further, the earphone set 2 comprises a high-frequency current suppressor 25 attached to the signal cable 24 at an end of the earphone 21 with covering an external circumferential surface of the cable housing 26 at the position.

【 0023 】

The high-frequency current suppressor 25 being adhered to an external circumferential surface of the cable housing 16 of the signal cable 14 is formed to have a hollow taper shape having a size of 1.55 mm in inner diameter, 3.30 mm in outer diameter of the upper portions, 2.0 mm in outer diameter of the lowest portions, and 5.5 mm in length of the taper portion. Besides, the high-frequency current suppressor 25 is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material. The high-frequency current suppressor 25 is formed by press molding to have the above-mentioned hollow taper shape and the size.

【 0024 】

(Third Embodiment)

Fig. 3 is an explanation view for showing an earphone set according to a third embodiment of the present invention, Fig. 3(a) is

a schematic perspective view showing the earphone set, Fig. 3(b) is an enlarged view showing a high-frequency current suppressor thereof.

**【 0025 】**

5        In Fig. 3, an earphone set 3 comprises an earphone 31, a microphone 32, a connection plug 33, and a signal cable 34 for connecting the earphone 31 and the microphone 32, and the connection plug 33. Further, the signal cable 34 comprises an inner conductor, an outer conductor, an insulation coating layer for 10 insulating the inner conductor from the outer conductor, and an insulation cable housing for coating the outer conductor substantially all over the length thereof. The high-frequency current suppressor 35 is formed on an exposed surface of the outer conductor 37 of the signal cable 34 in this portion.

15      **【 0026 】**

Moreover, the high-frequency current suppressor 35 is consisting of magnetic loss thin film (granular magnetic thin film) composed of  $Fe_{72}Al_{11}O_{17}$ . The high-frequency current suppressor 35 is formed to have a length of 5.5 mm and a film thickness of 1.5  $\mu m$  on 20 a surface of the outer conductor 37 of the signal cable 34.

**【 0027 】**

(Fourth Embodiment)

Fig. 4 (a), and Fig. 4 (b) is an enlarged sectional view for showing an earphone set and a microphone system according to a 25 fourth embodiment of the present invention

**【 0028 】**

In Fig. 4, within the earphone 41 and microphone 42, the inner conductor and the outer conductor are connected to the speaker portion 48, the micro portion 49, respectively. A high-frequency

current suppressor 45 is formed on a part of the signal cable 44 comprises outer conductor, in other words, between the outer conductor and the insulation cable housing.

【 0029】

5 Further, the high-frequency current suppressor 45 is consisting of magnetic loss thin film (granular magnetic thin film) composed of  $Fe_{72}Al_{11}O_{17}$ . The high-frequency current suppressor 45 is formed to have a length of 4.2 mm and a film thickness of 1.9  $\mu m$  on the surface of the outer conductor 47 of the signal cable 44.

10 【 0030】

(Fifth Embodiment)

Fig. 5 (a) and Fig. 5 (b) is a schematic perspective for showing an earphone set and a microphone system according to a fifth embodiment of the present invention.

15 【 0031】

In Fig. 5, a high-frequency current suppressor 55 itself is used as a molded resin constructing a case of the earphone 51 and the microphone 52.

【 0032】

20 Herein, the high-frequency current suppressor 55 is consisting of a resin including composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material. The high-frequency current suppressor 55 is formed by press molding to have a structure  
25 illustrated in Fig. 5.

【 0033】

Hereinunder, description will proceed to measuring effects of suppressing effect against high-frequency electromagnetic waves in the earphone set using the high-frequency current suppressor

according to the first through the fifth embodiments.

【 0034】

In Fig.6, at first, a tube having 2.5 mm in diameter and 15 mm in length, which has in its central a through hole having 0.5 mm in diameter is prepared. Next, a copper wire having 0.5 mm in diameter and 300 mm in length is penetrated through the hole. The composite magnetic material used in the first, the second and the fifth embodiments is then attached to a central portion of the copper wire in the length direction thereof to obtain a primary line including a primary high-frequency current suppressor. On the other hand, a granular magnetic thin film used in the third and the fourth embodiments is formed by sputtering on a external circumference of the above-mentioned copper line to have a length of 15 mm to obtain a secondary line including a secondary high-frequency current suppressor. Both ends of the primary line including the primary high-frequency current suppressor are connected to a network analyzer to investigate transmission characteristics between two ports.

【 0035】

As a result, suppressing effects between 20dB and 35dB can be obtained at quasi-microwave band in any of the primary and the secondary high-frequency current suppressors. Besides, other than the high-frequency current suppressors depicted in the above embodiments, larger suppressing effects can be obtained by changing material composition or size thereof.

【 0036】

Besides, the earphone set of the present invention is not limited to such a use. The earphone set of the present invention can be applied to various electronic equipments for enjoying music or

movies, in which an earphone or a headphone is generally used.

### 【 0037】

#### 【 Effects of the Invention】

As described above, according to the earphone set of the present invention, a high-frequency current suppressor is added to an earphone or a microphone itself, alternatively, to a part of a signal cable for connecting the earphone or the microphone into a terminal equipment for mobile communication. High-frequency current generated in a signal cable by electromagnetic waves produced from the terminal equipment can be reduced. Therefore, it becomes possible to provide an earphone set which is able to prevent an increase of SAR value in a human head by the electromagnetic waves.

#### 【 Brief Description of the Drawings】

【Fig. 1】 An explanation view for showing an earphone set according to a first embodiment of the present invention, Fig. 1 (a) is a schematic perspective view showing the earphone set, Fig. 1 (b) is an enlarged view showing a high-frequency current suppressor thereof.

【Fig. 2】 An explanation view for showing an earphone set according to a second embodiment of the present invention, Fig. 2 (a) is a schematic perspective view showing the earphone set, Fig. 2 (b) is an enlarged view showing a high-frequency current suppressor thereof.

【Fig. 3】 An explanation view for showing an earphone set according to a third embodiment of the present invention, Fig. 3 (a) is a schematic perspective view showing the earphone set, Fig. 3 (b) is an enlarged view showing a high-frequency current suppressor thereof.

【Fig. 4】 Fig. 4 (a), and Fig. 4 (b) is an enlarged sectional view

for showing an earphone set and a microphone system according to a fourth embodiment of the present invention

【Fig. 5】 Fig. 5 (a) and Fig. 5 (b) is a schematic perspective for showing an earphone set and a microphone system according to a fifth embodiment of the present invention.

【Fig. 6】 A drawing for showing the measuring effects of suppressing effect against high-frequency electromagnetic waves in the earphone set using the high-frequency current suppressor according to the first through the fifth embodiments.

10      【Explanation of the mark】

1, 2, 3    earphone set

11, 21, 31, 41, 51    earphone

12, 22, 32, 42, 52    microphone

13, 23, 33    connection plug

15    14, 24, 34, 44    signal cable

15, 25, 35, 45, 55    high-frequency current suppressor

37    outer conductor

47    inner conductor

48    speaker portion

20    49    micro portion

**【 Name of Document】 Abstract****【 Abstract】**

**【 Problems】** To provide an earphone set which a high-frequency current suppressor which is capable of being readily attached to the body of an earphone, a microphone, a part of a signal cable, or the like, and which can reduce unnecessary high-frequency current generated in the signal cable due to induction of the electromagnetic wave produced from a terminal equipment, and the like.

5           **【 Solving Means】** An earphone set characterized in that an earphone set 1 comprising a connection plug 13 connected to an output terminal of the earphone, and earphone 11, and a signal cable 14 for connecting the connection plug with these terminals, wherein a high-frequency current suppressor 15 consisting of soft magnetic material is added at least partially to any one of the connection plug, the earphone, and the signal cable.

10           **【 Drawings】** Fig. 1

Applicant's

filed on the 17th April, 2000

Number=TK120418

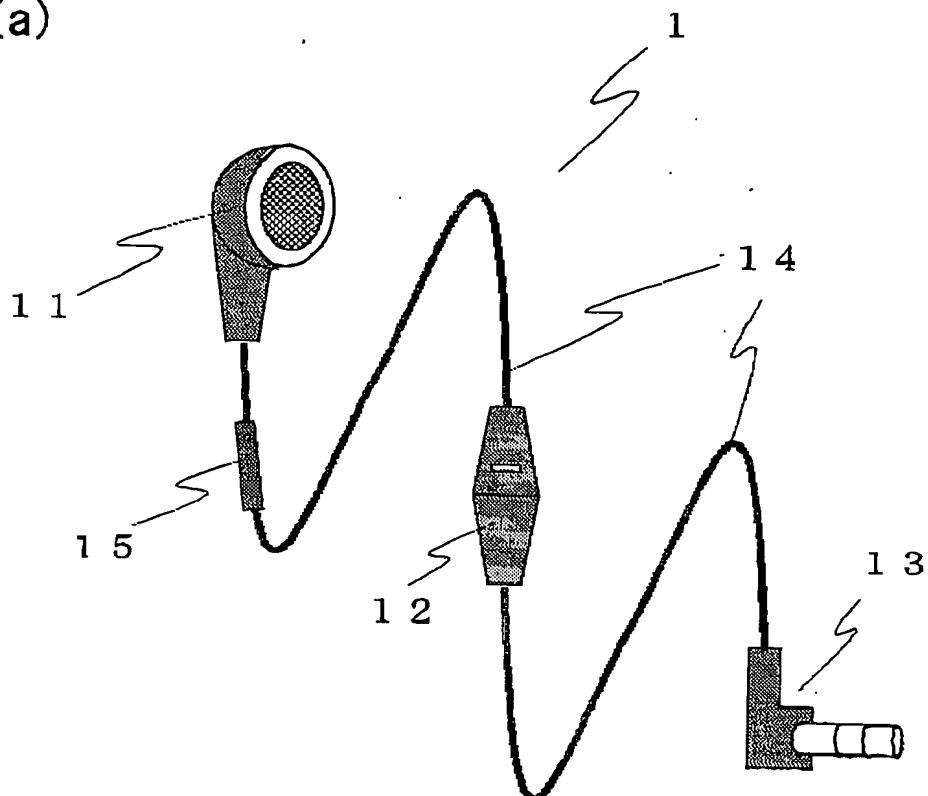
Japanese Patent Application No.114912/2000

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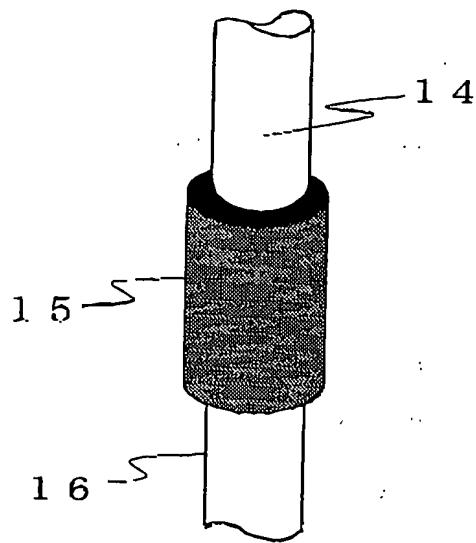
【Name of Document】 Drawings

【Fig 1】

(a)

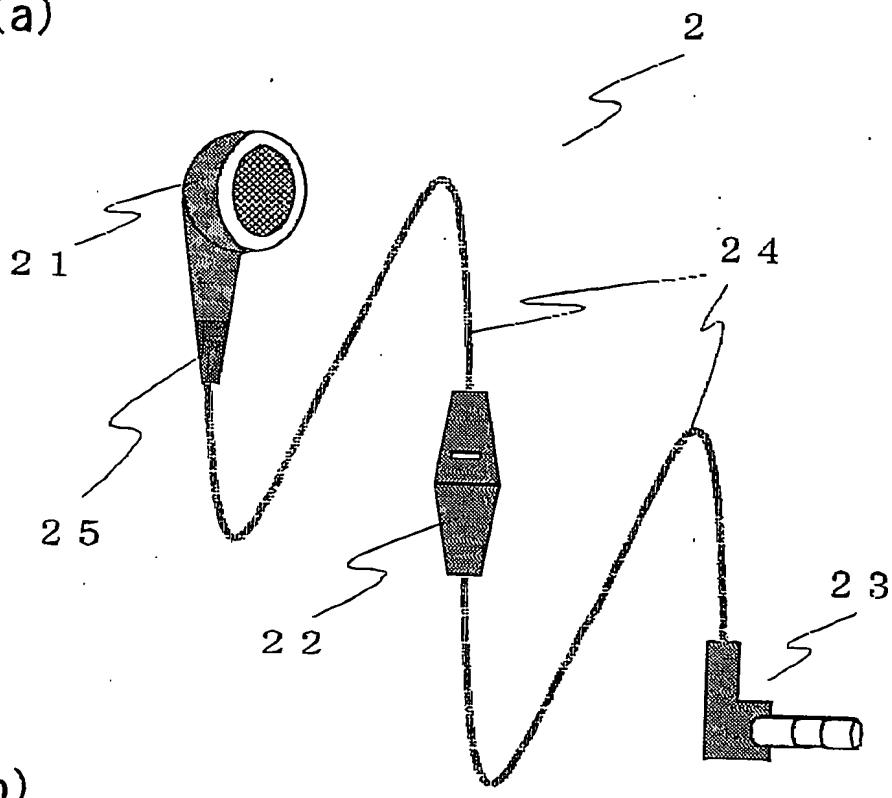


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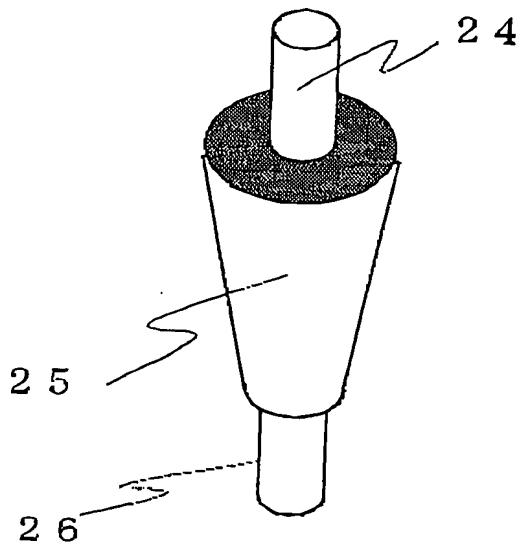


[Fig 2]

(a)

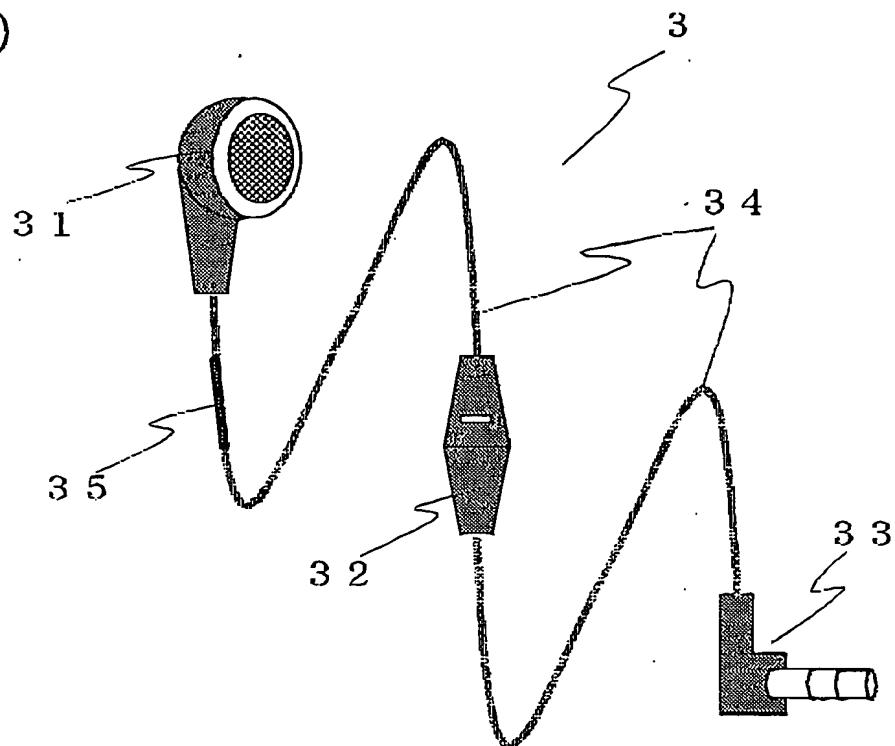


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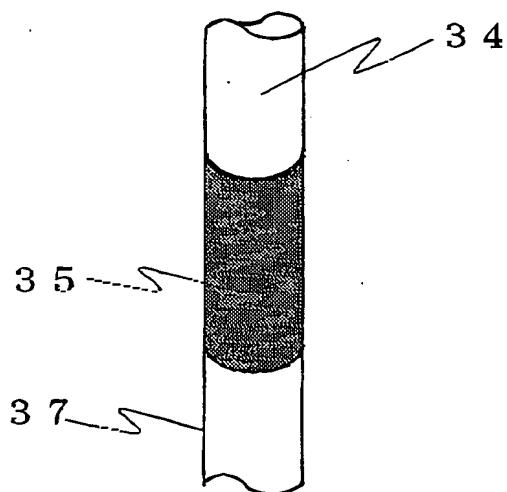


【Fig 3】

(a)

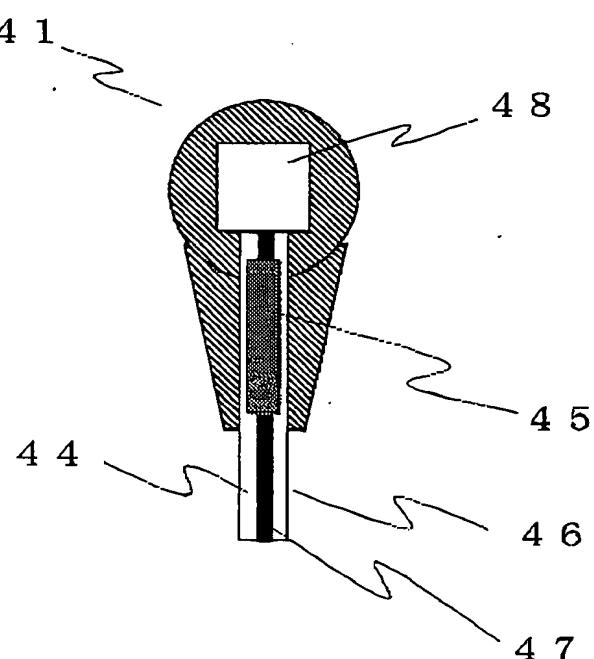


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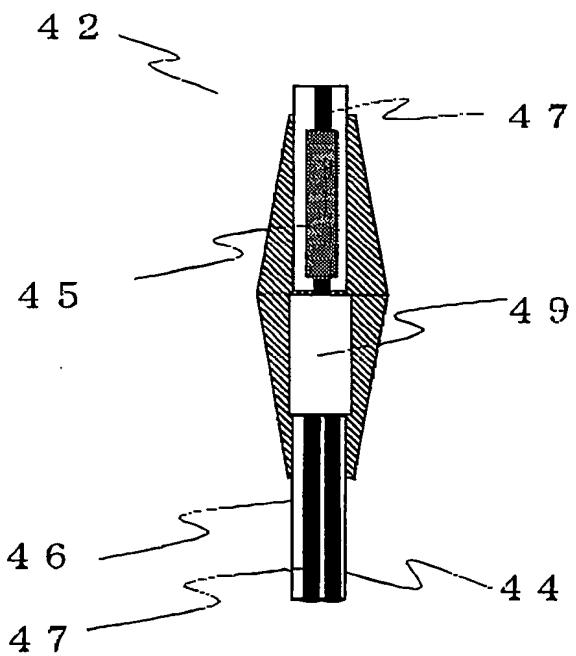


[Fig 4]

(a)

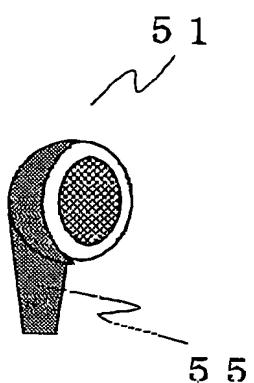


(b)

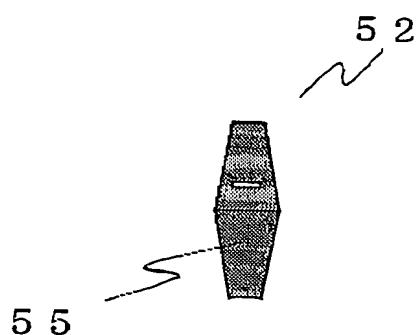


【Fig 5】

(a)



(b)



[Fig 6]

